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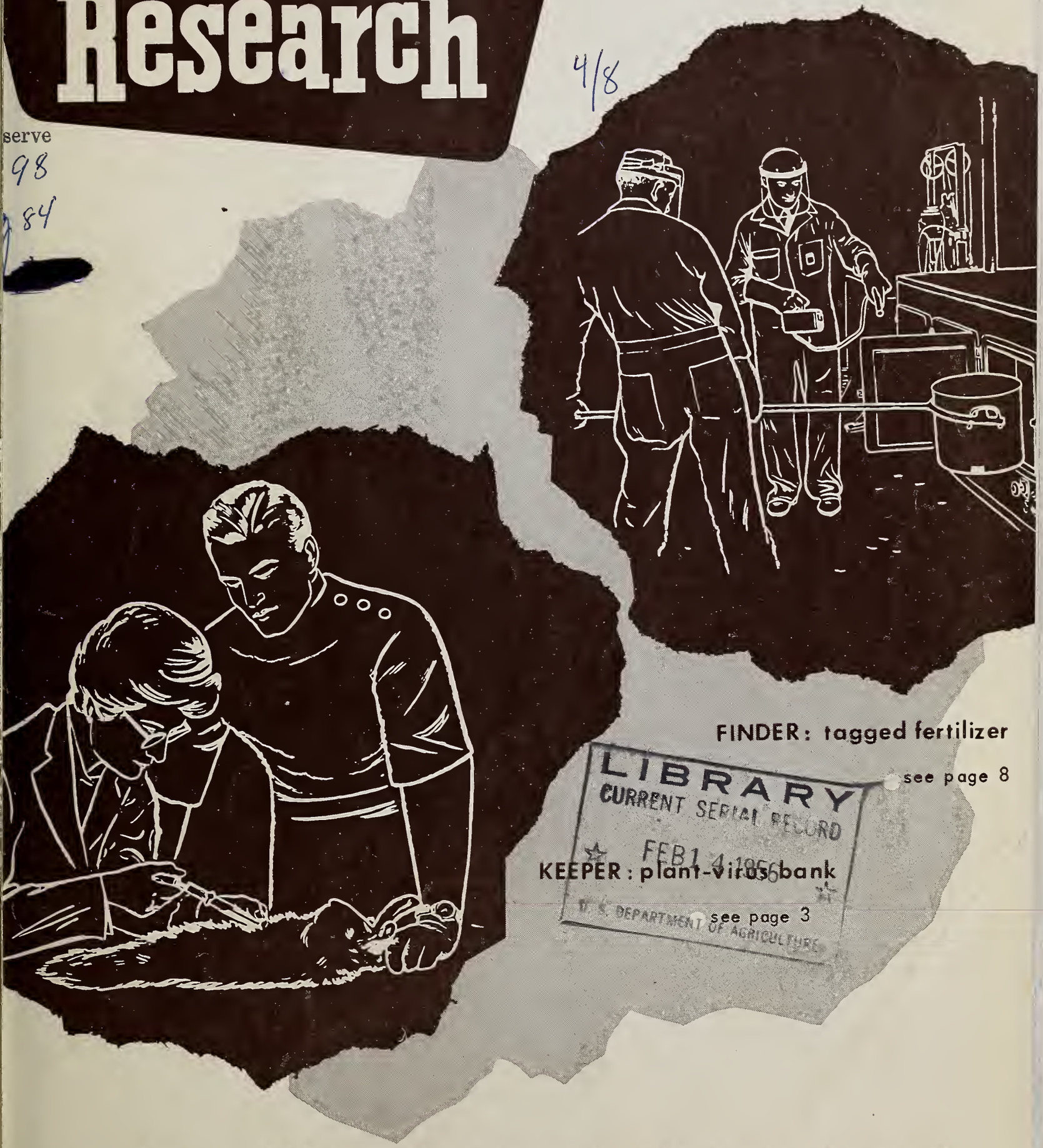
AGRICULTURAL Research



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UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL
Research

Vol. 4—February 1956—No. 8

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Relation

Farmers usually meet research through organizations like extension—not directly through researchers. Since findings are fed to users through these channels, research and education must be coordinated if either is to be effective.

One of the best-coordinated areas is cotton production.

Take the "one-variety community" program—conceived to get adapted varieties into use. It has brought premiums to growers, provided buyers "even-running lots." and done away with "gin-run seed" in many communities. Many inferior varieties have disappeared—92 percent of the cotton acreage in the seven southeastern States is now planted to four varieties.

Based on research, the one-variety community idea was originally carried to the field by research people with the cooperation of the Federal Extension Service. This program is now a part of the new extension-sponsored Cotton-Farm Demonstration Plan that worked so well last year.

Then there's ginning. Research has made many substantial contributions. The recipro-cleaner, the stick remover, the lint cleaner, and the green-boll and rock trap are only a few of the devices that have improved the efficiency of gins.

These research developments were carried to ginners by extension people. They are doing an outstanding job. All the cotton States now have extension ginning specialists, and the Federal Extension Service provides two engineers who train replacements and visit gins throughout the Belt. Last year, 2,000 foremen got practical instruction in efficient ginning. Through such work, the proportion of cotton graded down because of rough gin preparation has been reduced from 7 percent in the early 1940's to less than 1 percent today.

These examples represent working experience in tying together the interests and efforts of research and extension. We need this effectiveness in other fields. And we need to keep the channel open both ways—research must have extension's help in setting up priorities and planning studies.

A close relation between the research and the extension arm of our public services is imperative if we are to give farmers the right packages of answers to their problems.

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Scientists are depositing plant viruses in

THE RABBIT BANK

Blood containing cereal-crop-virus antibodies is withdrawn for disease test.

The antibodies produced help identify cereal-crop diseases

A BANK of antisera to be used in identifying major virus diseases that attack cereal crops is being built by USDA scientists and cooperating researchers at the Nebraska experiment station, in Lincoln.

Rabbits are being used in this bank as living sources of antibodies. With these antibodies scientists can make tests to determine the presence of barley-stripe mosaic, brome-mosaic virus, or other similar diseases that cause heavy losses to growers of small grain in this country each year.

Viruses—whether in plants or in animals—are made up largely of proteins. Thus, any warm-blooded animal forms antibodies to an injected virus. Specific only for the virus injected. the antibodies are found in the serum portion of the blood.

Once a stock supply of antisera has been prepared, scientists will have a faster method of virus-disease identification than those now used. This will speed up breeding for resistance to such diseases by enabling breeders to rid stock of infected material without waiting for plants to mature. It's also expected that the bank will provide for closer study of the diseases, their sources, how they are spread, and their relationship to each other.

In building the bank, ARS serologist Ellen Moorhead and biochemist M. Brakke get virus from the juice of diseased plants and inject this virus into rabbits. Their reaction is similar to that of humans injected with diphtheria toxin-antitoxin, or smallpox vaccine. We don't get the disease. Neither do rabbits injected with plant virus—they merely become sources of the antibodies to this virus.

Diseased plants can be field or laboratory tested with the antibodies in the rabbits' antiserum. If this antiserum and the virus under test are from the same disease, a precipitation forms in the test tube. None forms if the virus and the antiserum don't represent the same disease.

Occasionally, if the concentration of virus in plant juice is very small, there may be no precipitation even though virus and antiserum are the same. Concentration and purification are thus among the greatest problems encountered by researchers in building the serum bank and in studying the nature of the viruses.

Rabbits in this living bank at Lincoln now contain the antisera of purified preparations of barley-stripe mosaic and brome-mosaic viruses and several of their strains. The bank also contains antisera to the viruses of potato X, tobacco mosaic, elm ring spot, and cucumber mosaic. Although they have no connection with the cereal-plant viruses, the latter diseases make useful laboratory tools because of their distinct reactions and common characteristics.

High-speed differential centrifugation of plant extracts is one method of virus purification. Juices obtained by grinding and pressing infected plants are placed in a centrifuge tube. The tube and contents are turned first at 4,000 revolutions per minute for 30 minutes, then at 30,000 r. p. m. for 2 to 3 hours, and again at 4,000 r. p. m. for 30 minutes. The lower speeds clear the liquid of unwanted material—the high speed packs the virus particles into a pellet at the bottom of the tube. Sometimes the whole process is repeated by the scientists to further refine the virus.

This procedure works well enough for several viruses. Others, such as wheat-streak virus, present problems. This one has been isolated but hasn't separated or purified sufficiently under ordinary centrifugation meth-

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ods. So Brakke is applying to it a successful technique he developed for purifying other stubborn viruses. One difficulty is the minute quantity of virus material with which he must deal. Under this new method, specific quantities of sucrose solutions are layered into a centrifuge tube, with the solution of greatest density at the bottom. Plant extracts are floated on top of the sucrose and the tube is centrifuged at 25,000 r. p. m. for varying lengths of time. The virus and the plant material separate, each coming to a level depending on its size and density. Frequently, the process must be repeated several times with denser solutions, and for different lengths of time, to obtain the purest preparations of virus. Thus far, this method has proved the best for purifying wheat-streak virus.

Viruses in a purified state are freed of bacteria and molds and stored at 4° C. or less until used. If they are to be used for making antisera, each virus or strain is injected into a rabbit—one virus to one rabbit. Injections are intravenous or intramuscular.

Experimentally, inoculants have been mixed with a saline solution or a mineral-oil-and-water emulsion as an adjuvant to regulate release of the virus antigens into the rabbit's bloodstream. Researchers found slower but more lasting response to viruses that were administered in emulsion.

After inoculation, the blood of each rabbit is tested periodically. The first test is to find out whether the inoculant is effectively building antibodies. Later tests are made to see if the desired titer or relative strength of the antiserum has been reached. Further tests determine whether the titer is stabilized at the desired level. If not, the rabbit gets booster shots of virus.

When the blood shows a desirable, stable titer, the rabbit is a living source of antiserum. Its blood can be drawn off in small quantities and used as needed for testing cereal viruses in either the field or the laboratory.☆

livestock

SWINE BRUCELLOSIS TEST—WORKING UNDER A HANDICAP

■ An unknown substance in the blood of some swine is believed responsible for false "positive" reactions in testing hogs for brucellosis.

Placing the substance with brucella antigen causes "clumping"—a reaction typical of results obtained in the standard "agglutination" test used to diagnose the disease.

Cooperating Federal-State researchers are trying to determine the nature of this substance. They're working under the supervision of veterinarian H. C. H. Kernkamp, of the University of Minnesota's School of Veterinary Medicine, in St. Paul.

Researchers have found that the blood (serum-antigen mixture) of most swine that gives the false positive reaction is inactivated in this respect if it is heated to 56° C. and held at this temperature for 18 hours. Specific brucella agglutinins actually existing in the blood are not affected.

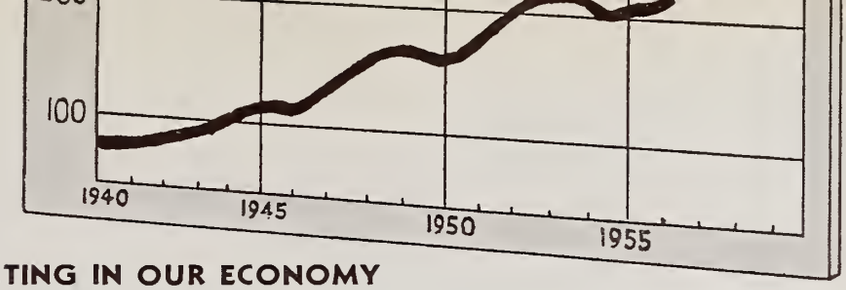
The false reaction is handicapping the testing of swine breeding herds. Humans can be infected with swine brucellosis as they can with cattle and goat brucellosis. This fact increases the importance of the ARS control and eradication work.

Researchers first suspected that some factor other than the disease was causing the reaction when they tested swine from a herd known to be free of brucellosis by tests conducted consistently and continually for at least 15 years. As a result, the scientists are convinced that a single test doesn't provide sufficient proof on which to establish presence or absence of the disease in herds of unknown status.

When reactors are found in the initial test performed on a breeding herd, at least two or more tests should be made as a basis for the final diagnosis. If any reactions on the first herd test are found to be less than incomplete at the 1-to-100 dilution of antiserum, the use of 2 or 3 tests permits checking and comparing reactions of the individual hogs. If, for example, the "titer" or potency of the reaction has not significantly increased in subsequent tests as compared with the first test, no infection is indicated. It is highly probable, say Kernkamp and associates, that the later tests will reveal significant titer increases when infection is present.

The researchers point out that brucellosis infection is clearly indicated where 30 percent of the animals show complete reaction at high levels and the remainder of the animals react to lower levels on the first herd test.☆

What's Keeping Land Prices Up?



ECONOMISTS SEE NEW FACTORS OPERATING IN OUR ECONOMY

JUST as a business takes periodic inventory of its plant and equipment, so USDA keeps tab on the value of the Nation's farm assets.

If agriculture is viewed as one large industry, its land, buildings, livestock, machinery and equipment, and liquid reserves have a current market value of $163 billion. The largest item is farmland and buildings, totaling over $91 billion currently. That's about 57 percent of all our farm assets.

Since more than half the total is in land and buildings, the annual changes in values of these items are watched closely by lending agencies, tax officials, agencies concerned with farm programs, and by people planning to buy or sell a farm.

Some view the price of farmland as a barometer of the general economic position of agriculture because this figure tends to reflect the degree of confidence that people have in farming as a profit-making business.

Most farm products flow into central markets where hourly, daily, and monthly prices are set. But farm real estate is a unique commodity. Its price is set by thousands of individuals who buy and sell farmland in thousands of communities each year.

To get accurate, timely reports on what's happening in the farm real-estate market, USDA maintains an extensive network of local observation posts throughout the country.

This network was started in 1912 with a voluntary crop-reporter group. In 1926, a special group of farm-real-estate dealers and other informed people were added. From reports of both groups, reliable statistics have been gathered to show the trend in farmland values for each State.

Currently, this team of nonpaid local observers totals about 16,000 farmers, who report 3 times a year, and about 10,000 special real-estate reporters, contacted by mail surveys twice a year. ARS production-economics research economists summarize, analyze, and evaluate the results and publish reports 3 times a year for general distribution.

What does this research show? It gives proof that land values tend to rise and fall with farm income and other indicators of business conditions. But the relationship is not perfect. Land values never rise as high or drop as low as earnings for a year or two seem to justify.

The outbreak of World War II sparked the longest steady rise in land values since records were started in 1912. Values had nearly doubled by late 1948, then dipped slightly from the mild post-war recession.

Then Korea came along and boosted values another 20 percent within 16 months. This put values at a new all-time peak 23 percent above the previous peak in 1920. As farm income started to decline in late 1952, land values also slipped—but not nearly as much as farm income.

Then a unique situation developed. Land values firmed and a rise began. It continued through 1955—setting a new peak—even though farm income was declining. Values had risen 8 percent since the 1952 low.

What happened to upset the hand-in-hand relationship observed over 43 years? From local observers' reports and other material, the economists conclude that several new factors are operating to offset the expected effects of lower income:

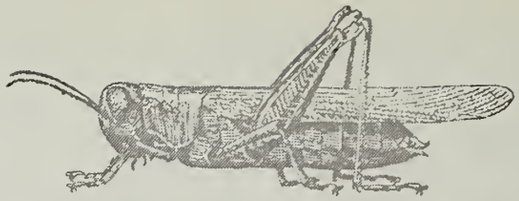
1. Farmers have continued to bid strongly for land to enlarge their farms. Caught in a squeeze between lower prices and rising costs, farmers find mechanization is one means of reducing production costs per unit. Often, more land is needed to make more efficient use of machinery farmers have or want to buy.

2. Credit to finance farm purchases has become more readily available. Several major lenders reduced interest rates and raised appraised values for loan purposes in 1954.

3. The booming nonfarm economy, and prospects for continued population growth, have indirectly helped to hold land prices up. This leads many people to believe that a farm is still a sound long-term investment. It is tangible and, they believe, more likely to maintain its value if inflation occurs. Noting the rapid increase in population and the fixed supply of land, many people are inclined to minimize the current less-favorable relationship between income and land price when they bid for land.

But too much reliance should not be placed on an increasing population to bring about a "scarcity value" of land. The potential capacity of our farm plant, along with technical advances in prospect over the next 20 years, seems capable of meeting increased food and fiber needs.

More efficient production of farm products, and returns to agriculture comparable with other sectors of the economy, may be more important problems in the years ahead than "food enough." The real basis for land values in the future, as in the past, must be their long-term potentiality for farm earnings.☆



Getting the jump on GRASSHOPPERS

HOW TO MEET THE THREAT THAT'S FORECAST FOR THIS YEAR

GRASSHOPPERS are all set to stage a massive attack next summer. Reports from USDA's thousands of cooperative observers, checked and double-checked by our entomologists, show that the insect could be very destructive over considerable areas of the West and Midwest and is a potential threat elsewhere.

The attack centers in the Southern Great Plains but involves much cropland in the Midwest and considerable rangeland throughout the West.

The red flag is up on 20 million acres of private, State, and Federal rangeland and a substantial cropland acreage in about a dozen States. Six years of drought in the Southwest aided the grasshopper — favored hatching and survival. Moreover, in some areas ranchers were reluctant to spend much for control on range where the grass was too poor to be grazed, yet ample for grasshoppers.

For years land and forest-management agencies, cattlemen, sheepherders, and hunters have been observing grasshopper numbers and giving valuable information to local, State, and USDA insect surveyors. Add to these the prospectors who have been combing remote areas of the West intensively for uranium in recent years and reporting on grasshoppers. Most of these reports have proved reliable and have furnished our surveyors valuable leads to heavy infestations.

Surveyors checked last summer at sample stops in areas that usually har-

OMINOUS SHADOWS across the land show where grasshoppers are on the march. Range is threatened chiefly in Texas Panhandle, eastern New Mexico, western Oklahoma, southern Kansas, southeastern Colorado, parts of Montana and California. Cropland is threatened in parts of northern Texas, northern Oklahoma, eastern Dakotas and Nebraska, and Missouri, Iowa, Minnesota, Wisconsin, Illinois, Indiana.

bor these pests, and at the reported centers of grasshopper buildup. They counted egg pods in the fall to detect any change in the picture. To do this, they scrape away debris. dig a square foot of soil, and shovel it through a screen to sift out the insect's egg pods.

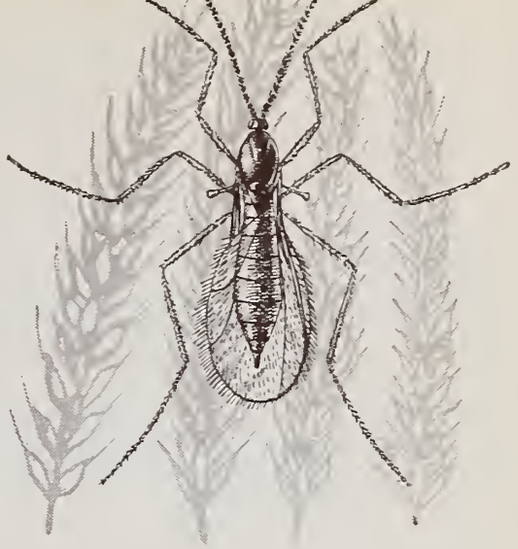
In the spring, grasshopper areas will be surveyed again to find what toll predators. parasites, diseases, and weather may have taken. Final plans for the 1956 control work will be based on this corrected picture.

ARS pest-control leader H. L. Smith and associates are busy with State and local officials and farm leaders pointing out where the danger spots are and helping to organize farmers in a grasshopper-poisoning program. In many parts of the country, there are signs of great interest in controlling grasshoppers this year.

Farmers control the insects on their own crop acres, with technical guidance from Federal, State, and local specialists. Where an outbreak on privately-owned rangeland threatens severe damage over wide areas and local facilities are inadequate to meet control requirements, spraying may be financed cooperatively by the Federal, State, and local agencies and landowners. In such instances, and particularly when migratory species are involved, the Federal Government will contribute up to, but not more than, one-third of the cost. The remaining two-thirds must come from States, Counties, and pooled funds of organized groups of ranchers.

Two ounces of aldrin in a gallon of oil normally kills 97 to 98 percent of the grasshoppers on an acre—benefits the range for 3 to 4 years. It's usually sprayed by airplane when there are the most adults and before egg-laying starts—mid-June to mid-September. Control costs about 60 cents per acre and ranchers generally consider their 20-cent share a good investment—a nickel per acre per year of good grazing they can expect.☆

BEHIND THE WHEAT-HESSIAN FLY BATTLE



■ Several varieties of wheat resistant to the hessian fly have been developed, but scientists are just beginning to learn what makes the wheat resistant to attack and what makes the fly destructive to wheat.

Resistance to the hessian fly may depend on wheat plants having enough stiffening matter to stand firm in spite of the softening effect of an enzyme secreted by the insect. And the insect's destructiveness may hinge on its proficiency in secreting this enzyme, which softens and breaks down the stiffening matter in the plant. The straw stiffener is known as hemicellulose, the insect enzyme as hemicellulase.

A graduate student, F. Y. Rafai, and two USDA scientists, entomologist E. T. Jones and chemist B. S. Miller, made the study at Kansas State College. The researchers found that the hessian fly uses his enzyme exudate in two ways. They think the enzyme changes the hard, insoluble hemicellulose into a soft material through which the fly can take in the plant juices by suction. Hemicellulose gives uprightness to the plant, but when that substance is broken down chemically, the plant loses stiffness and becomes flabby. Also, the fly buries its mouthparts into this pliable substance and gets a snug seal for its sucking operation.

Some wheats exceed others in their content of hemicellulose, chief constituent of cell walls. It is especially abundant in the plant's vascular tissues. In the Kansas studies, wheats rich in hemicellulose were fly-resistant. A sensitive experimental instrument measured these differences in hemicellulose in terms of the plant's resistance to shearing.

The wheat leaf forms a sheath where it joins onto the stem. This sheath is not only the insects' feeding place but also the place where the larvae must develop into pupae and adults. Fly larvae apparently can't make enough "elbow room" to molt and grow if the plant has enough hemicellulose to maintain its stiffness and snug fit of the sheath in spite of the enzyme action. Unable to develop normally on resistant plants, most of the flies die young—usually as small larvae.

Rafai, Jones, and Miller think it's more than just coincidence that fly-resistant wheats contain enough hemicellulose to withstand a normal quantity of the insect's enzyme exudate and yet remain stiff.

This study hasn't given us positive evidence or all the information we need on the parasite-host relationships. But it points out an area that needs more study. By understanding these relations fully, entomologists and plant breeders could work more directly and get quicker results with both new and old strains of hessian flies.☆

FERTILIZER TAGGED HERE

Phosphates get a radioactive tag in this plant—then help scientists study crop plants

RADIOACTIVE phosphate fertilizers for experimental use are made to order in a small plant operated by USDA at the Agricultural Research Center, Beltsville, Md. The plant was set up with the cooperation of the Atomic Energy Commission and the fertilizer industry.

Research using radioisotope-labeled phosphates is aimed at helping farmers get their money's worth from the billion dollars or more spent for fertilizers each year.

How much phosphate fertilizer do crops need? What is the value of water-insoluble phosphate in mixed phosphates? What form—powdered, granular, liquid—best utilized? At what stage of growth and where should the fertilizer be applied to do most good? These are some of the questions the experiments are helping to answer.

For example, experiments with corn have shown that the plant uses a high proportion of phosphate fertilizer early in the growing season and very little at any other period of growth. On the other hand, potatoes absorb phosphate throughout the growing period.

Fertilizer that has been accurately assayed for nutrient content is processed with known amounts of a radio-active element such as phosphorus (P–32) to make "tagged" fertilizer for agronomic experiments. This material is applied to the soil or directly to the plant. The uptake and transformation of the fertilizer by the plant, and its course through the plant, may be traced by a combination of radioactivity assay and chemical analysis of harvested plant material at various stages of growth.

During the past year, the Beltsville plant processed 107 units (31 grams each) of irradiated potassium phosphate received from the Oak Ridge National Laboratory. The phosphate was incorporated into fertilizer containing 265 pounds of P_2O_5. This tagged fertilizer was used in 41 experiments bearing on soil fertility and fertilizer evaluation by ARS, State experiment stations and universities, and cooperating agencies in Canada and India.

The manmade radioisotope of phosphorus—P–32—is classed as moderately dangerous. For handling the comparatively large quantity of this isotope at the Beltsville fertilizer plant, special facilities, methods, and equipment have been devised to protect the personnel from radiation hazard. Mixing operations are done under hoods with blowers that remove fumes and dust through a filter system. Long-handled tools, plastic shields, respirators, rubber gloves, and other safeguards are used by workers.

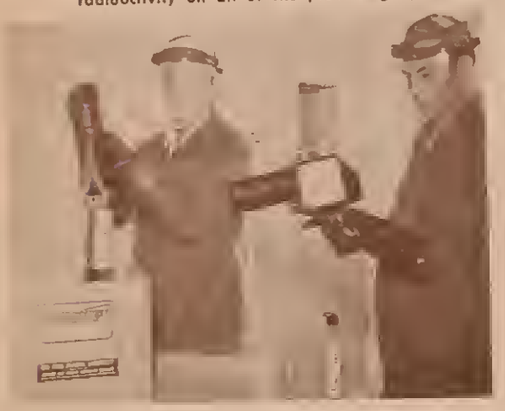
Monitoring devices that detect the amount of external radioactivity to which the men are exposed are used on all these fertilizer processing operations. Men wear film-dosimeters while working at the plant. The film is changed and developed periodically to determine the amount of exposure to which workers have been subjected.

The experimeter, fertilizer plant, and Oak Ridge Laboratory must cooperate closely to have the tagged fertilizer ready when it is needed during the growing season. Potassium phosphate is bombarded by neutrons in a nuclear reactor for 28 days to produce the P–32 radioisotope. Within 10 days after receiving the radioactive potassium phosphate, the Beltsville plant completes the manufacture and assay of the tagged fertilizer required for a particular experiment. Greenhouse tests with minimum amounts of isotope are often helpful in working out the timing and pattern of fertilizer application for a field test.

The rate of decay of a radioisotope is measured by the time required for its activity to decline to half value; this is known as its half-life. P–32, for example, has a half-life of 14.3 days. This means that at the end of 14.3 days, only half of the radioactivity of a certain concentration of P–32 remains. At the end of the succeeding 14.3 days, only half of the residual half of radioactivity will remain, and so on until the amount of radiation can no longer be measured by instruments commonly used for this purpose. In the concentrations used for agronomic research, the useful life of P–32 (or the period during which radiation can be accurately measured) is at best about 10 times the half-life, or approximately 5 months. This is long enough to carry an experiment through a complete field-crop growing season.

The radiation characteristics of P–32, together with the importance of phosphorus in plant nutrition, account for its wide use in agronomic research. Cooperative phosphate fertilizer studies are being carried on with many crops and in many places. Such work is adding to the knowledge that will help farmers improve crop production by making best use of fertilizer without waste.☆

1. Radioisotope of phosphorus (P–32), to be used for tagging fertilizers, is lifted with long-handled tongs for placing in plastic holder. Special precautions protect men from radiation hazard. Monitoring devices detect amount of external radioactivity on all of the processing operations.

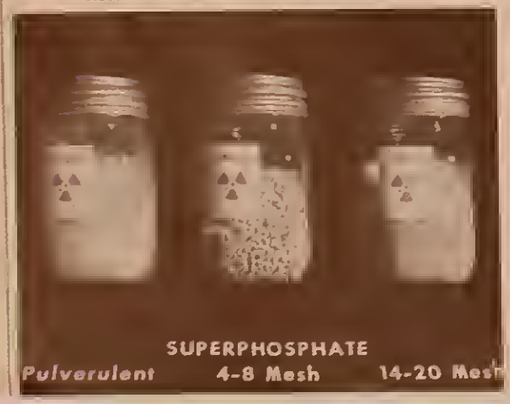


2. Radioisotope solution is poured from the shielded graduate into mixer containing crushed phosphate rock of known nutrient content. Sulfuric acid is then added. Materials are stirred mechanically while radioisotopes are distributed by chemical action of the acid on the phosphate, resulting in radioactive fertilizer.

3. To cure, the radioactive fertilizer is placed in a drying oven for about 2 days, when it becomes hard and porous. It is kept in the container in which it was mixed. Transfers of radioactive material from one container to another are kept a minimum during the manufacturing process to reduce hazard to workers.

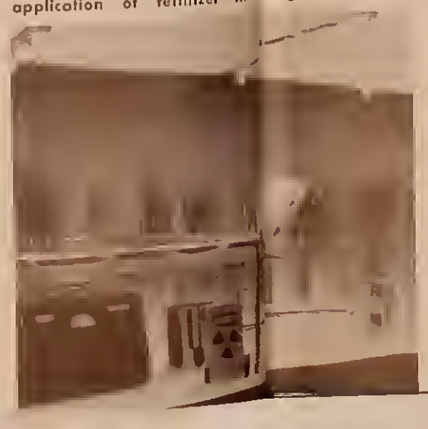
4. Excavating fertilizer out of container is the next step. The can, clamped to a machine, is rotated in a horizontal position. A cutting blade with a 7-foot shaft is held by hand and inserted through slots in the framework into solid fertilizer. As rotating material is shaved into pulverulent form, it falls into hopper.

5. Granule size of fertilizer may affect plant's absorption and, if fertilizer is water soluble, rate of leaching out of the soil. Screening it through meshes of different degrees of fineness separates fertilizer material according to particle size. Three most commonly used sizes are shown.



6. This package contains measured amounts of tagged fertilizer in jars ready for shipment after final check for radioactivity. Accurate assay data on each shipment are given researcher. Manufacture, shipping, and use of fertilizer must be timed so the experiment will be completed during useful life of radioisotope.

7. Pretesting under controlled greenhouse conditions helps experimenter get most out of a costly field test. The plants are grown in soil mixed with tagged fertilizer. How the plant uses the fertilizer in the greenhouse determines timing and pattern of application of fertilizer in larger field test.



8. In this experiment, tagged fertilizer is applied when corn is planted. Scientist with portable Geiger counter determines if radioactive material has been adequately covered by soil to make it harmless. Since tagged fertilizers give off radiation as they disintegrate, they can be traced in soil or through a plant.

How plants get Phosphorus

UNDERSTANDING OF THIS COMPLEX PROCESS CAN LEAD TO BETTER USE OF OUR FERTILIZERS AND SOILS

PHOSPHATE nutrition of plants is a complicated process in which both plant and phosphorus are pawns of another soil unit, the hydroxyl ion.

USDA research shows plants can't take up all forms of soluble phosphates that are within reach, as most scientists have assumed. Actually, plants absorb two forms—the di-hydrogen and the mono-hydrogen phosphate ions. These ions are not equal in effectiveness, generally not equal in supply. That's where hydroxyl ions enter the picture. Depending on their abundance in the root zone, hydroxyls dictate how much of the total phosphates shall be in each of these forms that are usable to plants.

Hydroxyls exercise dominance in another way, too. They interfere with a plant's absorption of phosphate ions—compete with them or block them off from the plant root. So, in a sense, the hydroxyls seem to work at cross purposes by impeding the uptake of ions even while boosting the plant's supply of usable ions.

The hydroxyl ion is one atom of oxygen plus one atom of hydrogen linked together as a chemical unit. The hydroxyl-ion concentration of a substance is reflected in pH value—a measure of acidity and alkalinity. Therefore, a growing-medium's acidity or alkalinity greatly influences the supply of usable phosphorus and its rate of uptake by the plants.

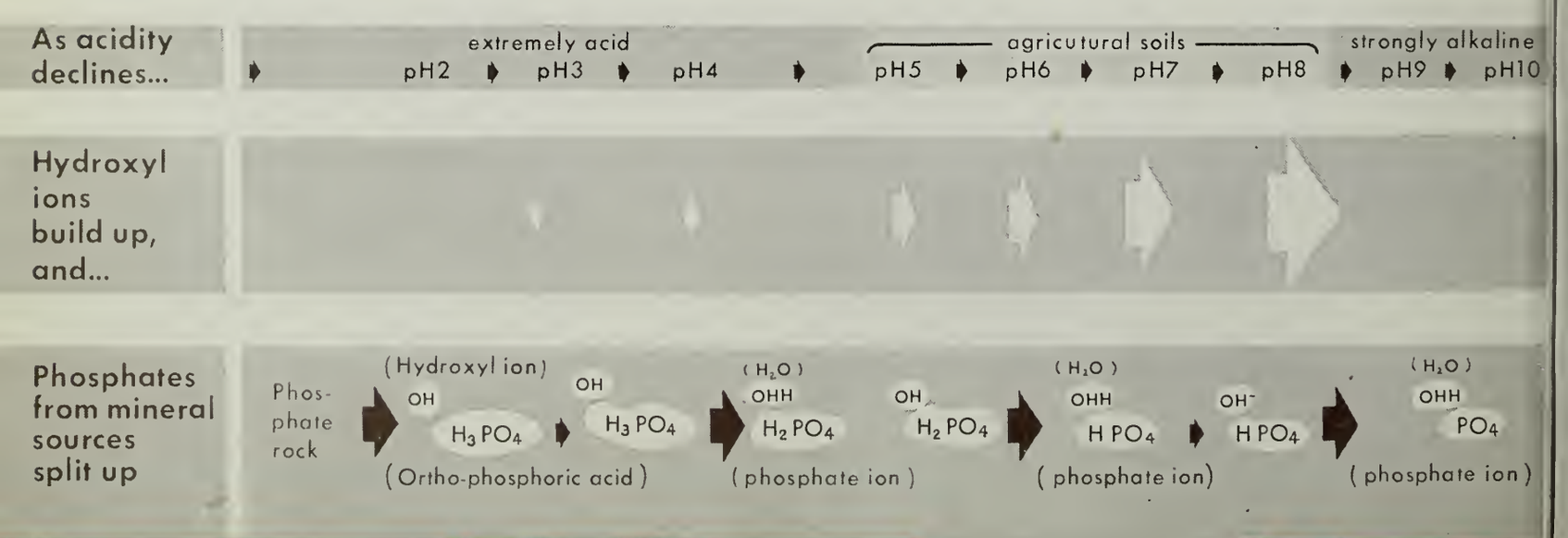
Biochemist C. E. Hagen and plant physiologist H. T. Hopkins, of ARS, found out how hydroxyl concentration regulates phosphate absorption by plants. This was shown by barley roots growing in solutions of known phosphorus content and pH value.

In the first place, by a series of reactions, the hydroxyl ion breaks into progresively simpler substances the more complex forms of phosphate material that may be present. That's symbolized in diagram below. At each reaction, the hydroxyl ion removes one of the phosphate's hydrogen atoms to complete a molecule of water (H_2O). Orthophosphoric acid (H_3PO_4) can arise from weathering or decay of the phosphorus-bearing rock, apatite, and become subject to this series of reactions. It is changed progressively to the di-hydrogen phosphate ion (H_2PO_4), mono-hydrogen phosphate ion (HPO_4) and simple phosphate ion (PO_4). Any ion removed or lost from the root zone is replaced by such reactions.

How far this progression goes depends, again, on hydroxyl ions—how great their concentration is. In an extremely acid soil with limited hydroxyl supply, much of the soil phosphorus is in a form not available to plants. At the medium-acidity levels with relative abundance of hydroxyls, available phosphates are relatively abundant—mostly di-hydrogen phosphate and little in mono-hydrogen form. Under neutral conditions, the mono- and di-hydrogen ions are in about equal amounts. But at alkaline levels with tremendous hydroxyl supply—thousands of times as much at pH 8 (moderately alkaline) as at pH 4 (extremely acid)—the supply is essentially all in mono-hydrogen form.

These findings, together with the observation that all plants aren't equally efficient in taking up orthophosphate, may help explain why, with our existing soils, we have the kinds of plants we do have. Some need only di-hydrogen phosphate, but in abundance. Some are self-sufficient with a trickle of the mono-hydrogen form. And others thrive only with reasonable amounts of both.

A major feature of hydroxyl ions' dominance over phosphorus nutrition



is that they compete with or block access of phosphates to plant cells (AGR. RES., December 1954, p. 6). In explanation, the plant's limited facility for absorbing ions is apportioned among several definite ion groups. A group's allotment is shared in proportion by that group's ions present—but not by ions of other groups. Potassium, rubidium, and cesium form one such group, for example, and compete with each other.

Surprisingly enough, Hagen and Hopkins found that plants treat the dihydrogen form and the mono-hydrogen form of phosphate as members of separate groups—permits neither to use any part of the other's entry quota. Even more surprising, the study showed that the hydroxyl ion competes with both phosphates. The more abundant the hydroxyl ions are—that is, the higher the pH value—the less the phosphate uptake.

In the experiment, the higher the pH value of a nutrient solution, the greater was the hydroxyl-ion concentration—10,000 times as many hydroxyl ions at pH 8 as at pH 4. Relatively much phosphorus was taken up by barley roots at pH 4 (extremely acid), but 11 percent less at pH 6 (medium acid), 74 percent less at pH 7 (neutral), and 85 percent less at pH 7.7 (mildly alkaline).

Tests made with conventional soil-testing kits show that alkaline soils of the West commonly have far more available phosphorus than the acid soils of the East. Experience has shown that a given crop may require as much as 300 pounds per acre of available phosphorus on alkaline soil but grow as well on acid soil with only 25 pounds per acre. Hydroxyl-ion competition at the root surface, demonstrated by Hagen and Hopkins, helps explain why this is so.

These findings should open the way to improved soil management and improved phosphorus nutrition of crops on soils of various pH values.☆

FORMULAS

FOR SHELTERBELTS

■ PLANTING TREES AND SHRUBS to protect from the wind is not new, but formulas for placing them to get best results have recently been reported by USDA agricultural engineer N. P. Woodruff. His recommendations grew out of cooperative research by the Kansas experiment station and ARS, at Manhattan. For the studies, the researchers used miniature shelterbelts in a wind tunnel (AGR. RES., December 1954, p. 8), then checked their findings with growing shelterbelts in the field.

To prevent soil blowing, the best grouping of tree rows proved to be a main 7-row belt planted at right angles to wind direction, with 2-row belts supplementing it on the leeward or downward side. This gave most space between belts and protected greatest length of ground.

Height of trees in the main belt—a factor termed H by the research engineers—and spacing between belts determined the amount the wind speed was reduced. For example, wind speed was cut half when spacing was 22H (22 times the average main-belt tree height) between the main belt and the first supplemental belt and 14H between the supplemental belts. If main-belt tree heights averaged 30 feet, the space between the main and the first supplemental belt would be 660 feet (22×30), between the supplemental belts, 420 feet (14×30). Shortening the distances between belts to 14H and 7H reduced air speed by 75 percent.

For crops, livestock, and buildings, a 7-row main belt with 2 single-row belts provided best protection. Air speed was reduced 50 percent with 19H space between the main belt and the first supplemental belt and 11H between the supplemental belts. Narrowing these distances to 13H and 6H resulted in 75-percent air-speed reduction.

Other tests showed that a 3-row shelterbelt consisting of a shrub row to windward, backed by 2 rows of trees, was not very effective in reducing wind speed—in fact, not as good as a single row of trees.

A 50-precent reduction was obtained with single-row belts when the first supplemental belt was spaced 17H to the lee side of the main belt and the second supplemental belt 13H beyond the first. Such a setup might prove advantageous on farms where growing crops do not need as great protection as is provided by more elaborate belts, and where savings in trees, labor, and space might be important.

A 7-row shelterbelt was made up of 4 rows of shrubs and trees on the windward side 7.5, 15, 20, and 25 feet tall. The tallest row—the fifth—was 30 feet. The 2 rows on the downwind side were 17.5 and 10 feet tall. Rows were planted 10 feet apart. Two-row belts consisted of 2 rows of tall trees with a row of shrubs on the leeward side.☆

New Weapons for Nematodes

SCREENING WORK HAS REVEALED SOME PROMISING CHEMICALS FOR VARIOUS METHODS OF TREATMENT

USDA SCIENTISTS are exploring better ways of fighting nematodes with chemicals. From the Central Florida Experiment Station, at Sanford, ARS nematologists J. Feldmesser and W. A. Feder have reported on 5 materials—2 bare-root treatments, 2 soil fumigants, and a drench—of possible value as nematocides.

Ultimate goal is a nematode-killing systemic—a spray that plants can absorb through their foliage and translocate into their roots—but the scientists are overlooking no good chemical, systemic or not.

So far, in 1½ years of screening work Feldmesser and Feder have determined the nematocidal properties of about 85 different chemicals as chamber fumigants, soil fumigants, soil drenches, and bare-root dips. Most of the chemicals are supplied by synthesizing laboratories at the Agricultural Research Center, Beltsville, Md., and by a number of industrial chemical manufacturers.

The two promising bare-root dip treatments are Netherlands-developed organic-mercury compounds that have proved highly effective in eliminating nematodes from the roots of a large variety of ornamental plants. Feldmesser believes these compounds—AAventa and AAbulba—may prove valuable to nurserymen concerned with planting and shipping nematode-free stock, perhaps to Federal quarantine inspectors for freeing tolerant ornamental imports of infection.

So far at Sanford, an hour-long root bath in a 1-percent solution of AAventa has destroyed meadow nematodes infecting the roots of these ornamentals: acalypha, aglaonema, azalea, caladium, camellia, cerissa, croton, dracena, gardenia, hibiscus, ixora, ligustrum, maranta, neanthebelle, peperomia, philodendron, podocarpus, pteris, rhektophyllum, scindapsus, sansevieria, and strelitzia. The plants were not damaged. AAbulba, more toxic to plant roots, has been used only on some bulbs.

The two most promising experimental soil fumigants are M–310 and Nemagon—outstanding because of their high toxicity to nematodes, their low toxicity to some plants.

At present, tobacco and truck farmers can use soil fumigants, but apple or grape producers cannot. D-D mixture, EDB, methyl bromide, and chloropicrin—the principal soil fumigants in use today—are highly toxic to plants. They must be applied to the soil *before* planting. M–310 and Nemagon can be applied around the roots of certain living plants. These chemicals are being field-tested in grape and other orchard crops.

Soil drenches, such as the new V-C 13, depend on long-lived toxicity. Applied to a plant root area, they destroy nematodes that emerge from roots into the soil—without damaging the root. Feldmesser and Feder are carrying out small-scale tests with V-C 13 against nematodes attacking the roots of ornamental plants.

Meanwhile, the search for a systemic nematocide goes on. The search is complicated by the need for a downward - moving chemical — apparently not too common among systemic pesticides. A plant regulator that moves from foliage to roots and even out of roots is MOPA (alpha methoxyphenylacetic acid). It has been investigated as a growth-regulating chemical by ARS plant physiologist J. W. Mitchell and his co-workers.

Nematologists are experimenting with MOPA on perennials, hoping it will prove repellant or even deadly to at least some types of nematodes. Or barring such an easy success, the scientists hope that MOPA's chemical structure may provide a clue to downward-moving systemics that can be joined with nematocides. ☆

BARE-ROOT DIP of AAventa killed citrus as well as nematodes but looks promising for many other plants. White solution getting root-dip trial by J. Feldmesser is V-C 13.

SOIL INJECTIONS help evaluate promising fumigants. Chemical injection into one corner of each square marked on ground serves one square foot of nematode-infested soil.

In 11 lactations 150,000 lbs. of milk.

Outstanding results come out of

HUNTLEY'S HOLSTEINS

High-producing animals from this research station have helped make dairying a major enterprise in Montana

DEVELOPMENT of a strain of dairy cattle highly pure in their inheritance for heavy production has been the major goal of Holstein breeding and sire-proving work begun at the U. S. Dairy Field Station, Huntley, Mont., about 37 years ago.

Today, the station can point to a herd average of 492 pounds of butterfat by young cows averaging 2 years and 11 months of age. This is equivalent to a hefty 600 pounds of annual production by a mature cow.

Records also show that 126 Huntley sires on loan to cooperating dairymen have produced daughters whose butterfat production has exceeded that of their dams by an average of 30 pounds. Further, daughters of 4 out of 5 Huntley bulls have excelled their dams in production performance, and 2 daughters out of 3 have produced more than their dams.

These results provide outstanding examples of accomplishment under a cooperative effort between Federal and State researchers and farmers.

The Huntley work has helped immeasurably to make dairying a major enterprise in Montana. At least two herds developed there by the use of Huntley blood lines have achieved national prominence by high average production in Holstein tests.

In addition, many Huntley herd sires are on lease to artificial insemination rings and are being used in the herds of land-grant colleges.

A key to the success of the program is the plan under which Huntley sires are loaned to dairymen. Started in a small way 35 years ago, this plan was first applied to nearby farms and later to farms throughout the State. Through such cooperation, high-producing herds developed with the aid of Huntley blood are now to be found in a number of the States and in Hawaii and Costa Rica as well.

Breeding work, according to ARS dairy husbandryman D. V. Kopland, started off for consistent high production with good butterfat test. No special effort has been made to breed for distinct family lines. But for the herdsman who likes family trees, the Huntley herd boasts blood of sires such as Governor of Carnation, Sir Pietertje Ormsby Mercedes, Sire Bess Ormsby Fobes, Johanna Rag Apple Pabsts, and many other well-known sires of the Holstein breed.

Breeding for type has not been neglected. Although high production has been the major goal, this hasn't prevented many loaned Huntley sires and their progeny from becoming consistent winners in the show ring.

For the stock retained, record-of-performance testing begins as soon as young females come into production and continues until the animals are disposed of for slaughter. Every female is production-tested on a 305-day or yearly basis under Advanced Registry rules of the National Holstein-Freisian Association. Certificates are maintained on all females that have completed their production records. The herd is milked twice daily and milk weights are taken each day. Butterfat tests are made on a 2-day basis each month. The Advanced Registry tests are usually confined to 2-year-old animals since older ones are used largely in feeding trials. But this does not interrupt continuous recordkeeping that's conducted by the station on these older animals.

Sire proving starts when a bull is about 18 months old. If his ancestry is known, the milk and butterfat records of his dam and those of the dams of his sire and his sire's daughters become part of his record.

A sire is usually about 2½ years old when his daughters begin to arrive. He is at least 5 years old before the production records of his daughters are available for comparison with the records of their dams.

A sire is "proved" when the production records of 8 to 10 of his unselected daughters are available. He's considered a good proved bull if the majority of his daughters outproduce their respective dams under comparable conditions. Proving continues through a sire's life, which commonly runs from 8 to 10 years or more.

There are roughly 150 animals in the Huntley working herd, maintained primarily for breeding and feeding research. Surplus animals are often sold to dairymen as foundation stock rather than being slaughtered.

Sales are held periodically. Males are priced, before the sale, at figures representative of their age and their worth as breeding animals on the basis of the records of their dams. Dairymen attending the sales of Huntley females may offer sealed bids.☆

food and home

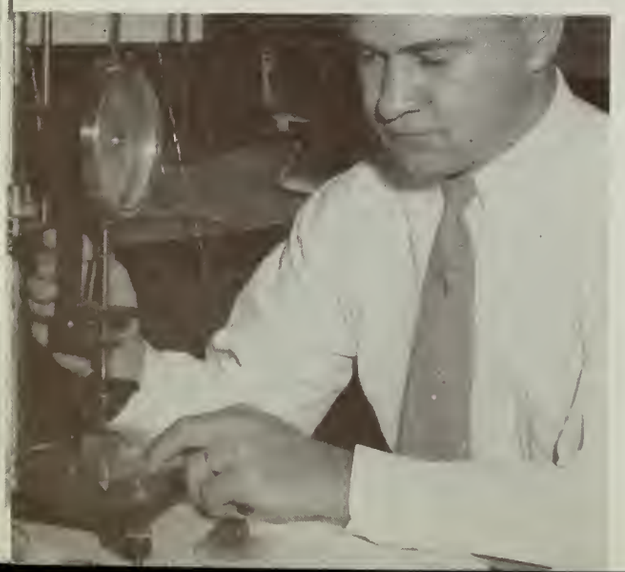
Science and Candy

PUMPING clarified cane juice through glass columns of special resins removes impurities. This is the key step in the ion-exchange sugar process.

WORKERS ARE PUTTING A VARIETY OF FARM PRODUCTS INTO CHEAPER, HIGHER-QUALITY CANDY WITH LONGER SHELF LIFE

DETERMINING equilibrium humidity—the relative humidity at which candy will neither gain nor lose moisture—is done by placing the weighed candy in a vessel kept at a predetermined humidity. Change in moisture is found by a weighing after storage.

MEASURING starch-jelly texture with a penetrometer is C. H. Mack. Tenderness retained in storage varies with combination of corn-sirup solids used.



CANDYMAKING nowadays is a blend of art and science. And cooperative USDA-National Confectioners' Association research is aimed at keeping our national sweet tooth well satisfied with high-quality products.

This research has shown that many excellent candies can be produced at less cost with turbinado sugar, which requires no refining. Another direct-consumption sugar—ion exchange—should also be cheaper. Research in the dairy field is adding to the number of forms in which milk solids can be used for the manufacture of candy. Other advances include a candy with improved keeping quality, use of fruit essences, improved slab dressings, and information on moisture equilibrium in candies.

Turbinado sugar is made directly from cane juice during harvest season, without refinement by bone char or carbon. It accounts for 5 percent of the 750,000 tons of sugar used annually in candy. Excellent chocolate goods, coatings, caramels, and other colored candies were made from this type of sugar at the Southern Utilization Research Laboratory. It was not suitable for clear, white, or brightly colored pieces.

Ion-exchange sugar (AGR. RES., February 1954, p. 6)—whiter and purer than turbinado—is being produced experimentally and should find a wide market in candymaking when available commercially. It is suitable for most of the candies in which turbinado sugar is unsatisfactory. White nougat, grained mints, and clear, hard candies differ only slightly in color from similar candies made with regular granulated sugar. Excellent clear pectin and starch jellies have also been produced experimentally.

Work on a military ration candy—a candy with improved keeping quality—has been very successful. The chocolate coatings and their centers—fudge, caramel, or nougat and caramel—remain firm at temperatures up to 100° F. The fudge-type candy contains sorbitol (from corn sugar), which gives it smooth texture and retards drying. The caramel and combination candy both contain sweet whey, which supplies protein.

In candy research conducted with dairy products, sweetened condensed whey, dry sweet whey, and a combination of sweetened condensed whey

POURING batch of experimental hard candy from small candy kettle onto specially dressed slab is F. J. Fahs, National Confectioners' Association candymaker at ARS utilization laboratory, New Orleans.

with dried sweet-cream buttermilk were used to make caramels. Maximum proportions of whey solids—about 13 percent—could be used in the form of dry sweet whey or sweetened condensed whey prepared by the Eastern Utilization Research Laboratory. Commercial trial batches of whey caramels are now being made by a number of candy manufacturers.

Several products have been found satisfactory for use as slab dressings in making small batches of hard candy. These are butyl stearate, ethyl stearate, ethyl palmitate, and ethyl esters prepared from completely hydrogenated cottonseed oil. Satisfactory slab lubrication without development of rancid odor or flavor was also provided by acetoglycerides—chemically modified fats and oils (AGR. RES., July 1955, p. 10).

Natural grape, apple, and strawberry essence (AGR. RES., August 1953, p. 11) was used in making delicious natural-flavor pectin jellies.

Studies on moisture equilibria—to improve shelf life—are now in progress. Cupping of coated candy, loss of gloss, chalky spots, and off-flavor are caused by loss of candy's original moisture content. If centers can be formulated so as to be in moisture equilibrium with the average relative humidities in which the candies will be stored, there will be little or no transfer of moisture into and through the coating. But the most desirable, soft centers are in equilibrium at higher humidities and lose moisture rather rapidly under average storage conditions.

Fine grades of calcium carbonate have been successfully used to cream fudge. Experiments were also made with this material to improve the graining of nougat. Researchers found that mixing about 2½ percent fine calcium carbonate with fat helped to disperse the fat throughout the batch with minimum whipping. The resulting nougat was very tender.

Tests were completed on starch jellies made with different combinations of corn-sirup solids. High conversion corn sirup produced more tender pieces. Combining invert sugar with high-conversion corn sirup gave even better results. Addition of individual pure sugars—dextrose and maltose—to regular corn sirup had little effect on jelly texture.☆

Cotton carpet cleaning: now it can be done in one visit

■ A DIFFICULT CLEANING problem—restoring heavily soiled wall-to-wall cotton carpets to bright shades and rich texture—has been solved.

Through contract research sponsored by USDA, scientists have found a way to get installed cotton carpets really clean in a single visit to a home. In the past, desired results have been achieved only after cleaners have made up to three calls.

Commercial production of both the cleaning machine and the special detergent necessary in this new method is expected in the near future.

Unlike most conventional rug-cleaning methods, this newly developed procedure uses large quantities of fresh, clean suds. These are actually worked through the carpet pile by a specially designed rotating brush.

After the action of the brush and detergent have loosened the dirt, suds and soil are sucked out of the carpet through a vacuum nozzle at the outer edge of the rotating brush.

The new procedure leaves a cleaner, drier rug than most ordinary cleaning methods, which let detergent and soil remain in the carpet.

The carpet next undergoes rapid-drying operation. Lastly, the texture of the pile is restored by an agitation-type vacuum cleaner.

The fundamental studies that led to development of this cleaning process are part of a larger USDA program to develop new and extended outlets for cotton. These studies were supervised through the ARS Southern Regional Research Laboratory, in New Orleans, and were carried on under contract by the Hoover Company of North Canton, Ohio.☆

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OFFICIAL BUSINESS

agrisearch notes

SEED OF A NEW, better-yielding variety of flue-cured tobacco is ready for growers. This is Dixie Bright 244, highly resistant to fusarium and bacterial wilt and moderately resistant to the destructive black-shank disease.

This variety was developed jointly by USDA and the North Carolina experiment station. Seed is obtainable from the North Carolina Crop Improvement Association—*not* from USDA or the State experiment station.

The new variety will be prized for its ability to grow on soils heavily infected with the three very destructive soil-borne diseases. In 6 years of field testing, it yielded a fifth more than Dixie Bright 101, a flue-cured variety that's resistant to bacterial wilt and black-shank disease.

WIDESPREAD SEARCH is underway for the threatening soybean cyst nematode, which was first found in this country in 1951.

So far as we know, it's still confined to its original area of about 900 acres near Castle Hayne, New Hanover County, N. C. However, regulatory officials of USDA and the North Carolina Department of Agriculture aren't taking chances. They're resurveying the Castle Hayne area to see whether the pest has spread. They're spot-checking up to 50 miles from there—in fact, wherever they think the pest might have been moved by the transfer of plant material, soil, or machinery.

Regulatory personnel, agronomists, and plant pathologists in soybean areas everywhere have been alerted to report for careful investigation any unexplained damage to soybeans. Regulatory problems raised by the nematode's presence in this country are also being investigated.

The soybean cyst nematode yellows and dwarfs soybean plants. It's one of the microscopic organisms often called "eelworms" or "threadworms." We're especially concerned because cyst-forming types are usually very persistent—extremely hard to kill. The mother nematode changes her body into a heavy-walled egg case or cyst that keeps eggs alive for years and ready to emerge at the proper signal.

The golden nematode of tomatoes and potatoes, for example, can survive over 9 years this way. The sugar-beet nematode, also a cyst-forming type, can be starved out by a proper 3- or 4-year rotation.

Survivability and other characteristics of this pest are being studied by ARS and North Carolina experiment station researchers. They hope to find some weakness in the pest that will enable us to control it.

WARM SOUTHERLY WINDS that bathe Florida from January to April may blow in pink bollworm moths from the Bahamas to reinfect our wild cotton plants.

Extreme South Florida is the State's only infested area now. Systematic cleanup of wild or dooryard cotton plants there eradicates the pest in many areas from year to year (AGR. RES., December 1955, p. 8). Yet bollworms continue to crop up.

USDA entomologists looked to the Bahamas, close offshore, where cotton hasn't grown commercially for half a century. They found wild cotton there, some infested, and think that's our source of infestation. If so, permanent relief to the Southeast depends on destroying all wild cotton and keeping it out of South Florida.

U. S. GOVERNMENT PRINTING OFFICE: 1956